Crucible: A System for Space Synthetic Biology Experiments

Completed Technology Project (2016 - 2017)

Project Introduction

The goal of this project is to expand the capability and methodologies in experimental extreme biology as a step towards Martian ecopoiesis. The objectives in meeting this goal are to (1) fabricate, assemble, and characterize the Crucible design prototype across a subset of Martian conditions including temperature, pressure, and light intensity and spectra, (2) characterize the survival and growth of an initial set of extremophiles using the Crucible prototype to be assembled at the NASA Ames Research Center, and (3) cultivate a diverse community of scientists and engineers across astrobiology, synthetic biology, and planetary sciences interested in adapting the Crucible for further developments such as flight, ionizing radiation exposure, and microgravity experiments

Anticipated Benefits

We propose the development of the Crucible chamber in partnership with UC Berkeley and Autodesk to build a chamber that will allow biology experiments under extreme conditions as a step towards Martian ecopoiesis. Martian Ecopoiesis, also known as planetary ecosynthesis or terraforming, is the artificial creation of a sustainable ecosystem on a lifeless planet. While several methods have been presented for this process, the utility of biological systems is certainly an important factor due to the adaptation of biology to an environment, continued development across industrial sectors in biomaterials and agriculture, and potential scalability of living systems. Despite the excitement surrounding and efforts to realize a terraformed Mars, very little has been carried out in the way of relevant experimental biology. Arguably one of the primary roadblocks in this field is the inability to carry out repeatable and reliable biological experiments under conditions sufficiently analogous to the harsh Martian environment. This roadblock has led to knowledge gaps in understanding (1) How to reliably replicate Martian conditions (2) How to source and filter biology of interest (3) How to characterize and engineer useful biological phenomena under Martian conditions (4) How to scale experiments sufficient to characterize enough biology to form a basis for continued engineering and (5) How to design experiments for interrogating partial gravity (Mars=0.38g) effects on biology in a space environment. Thus, the capability needed for expanding experimental extreme biology is the ability to reliably carry out repeatable, high-throughput experiments under a variety of environmental conditions in parallel across multiple laboratories interrogating varied biological systems. The Crucible chamber will meet this capability need.

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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Ames Research Center (ARC)

Responsible Program:

Center Innovation Fund: ARC CIF

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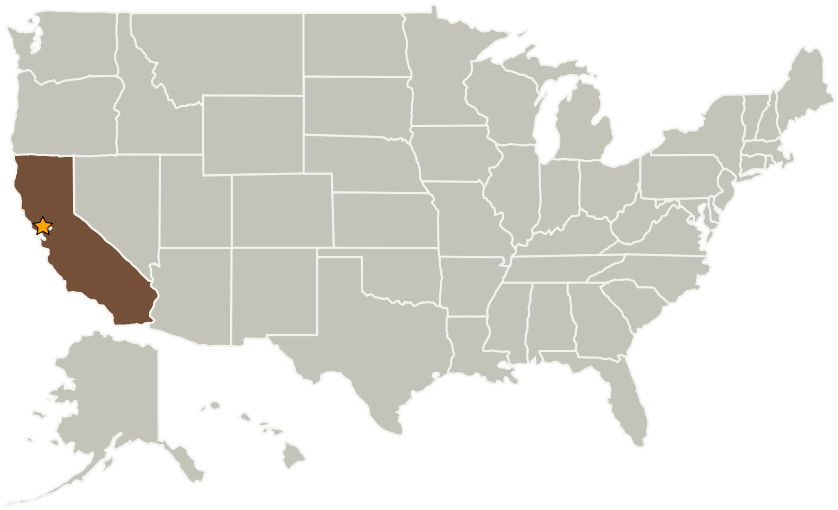
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Ames Research Center(ARC)	Lead Organization	NASA Center	Moffett Field, California
Autodesk	Supporting Organization	Industry	
University of California-Berkeley(Berkeley)	Supporting Organization	Academia	Berkeley, California

Primary U.S. Work Locations
California

Project Management

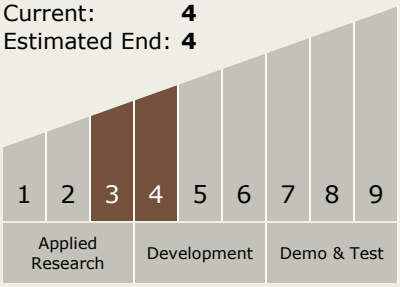
Program Director:
Michael R Lapointe

Program Manager:
Harry Partridge

Principal Investigator:
Christopher P Mckay

Technology Maturity (TRL)

Start: **3**
Current: **4**
Estimated End: **4**



Technology Areas

Primary:

- TX06 Human Health, Life Support, and Habitation Systems
  - TX06.3 Human Health and Performance
    - TX06.3.5 Food Production, Processing, and Preservation

Target Destinations

The Moon, Mars, Earth